The Development Of A Linked Modelling Framework For Analysing Socio-economic Impacts Of Energy And Climate Policies in South Africa

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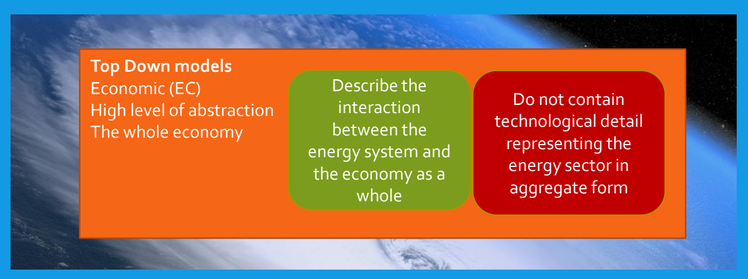
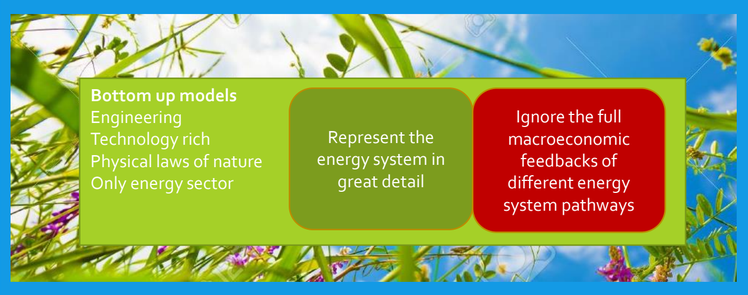
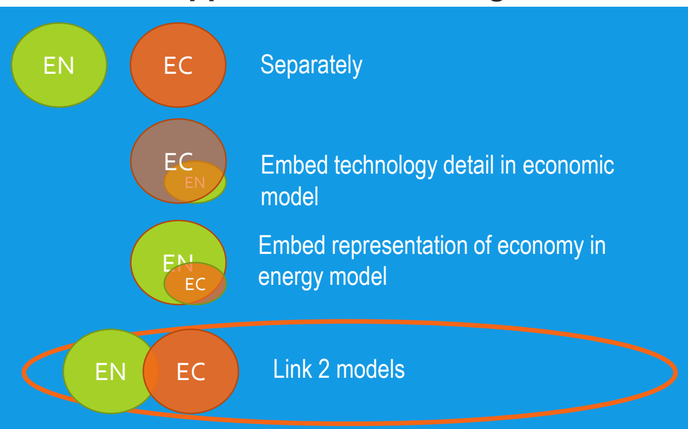
Introduction



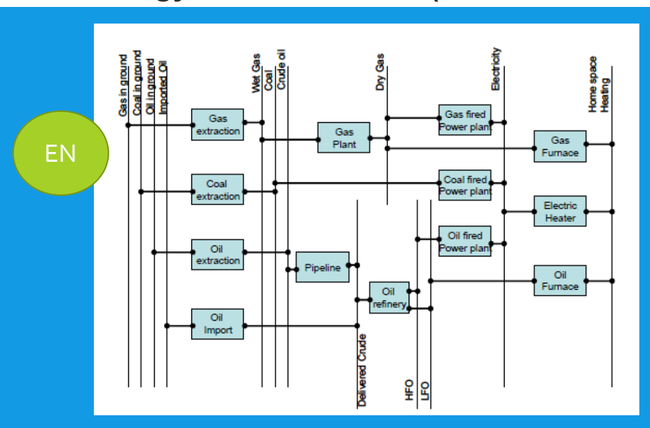


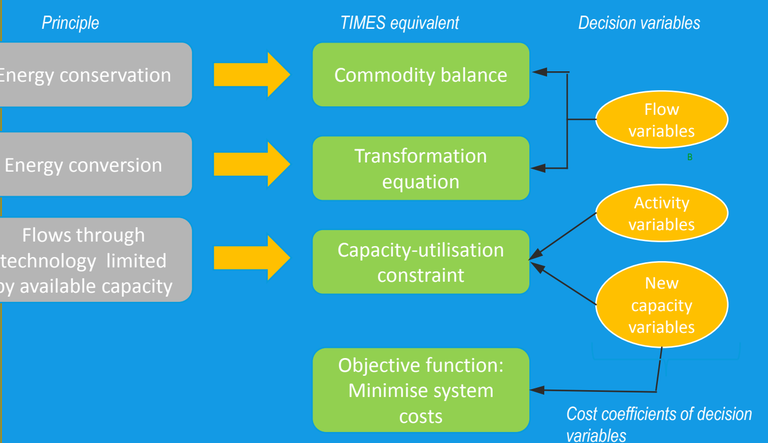
Common Approaches for linking models



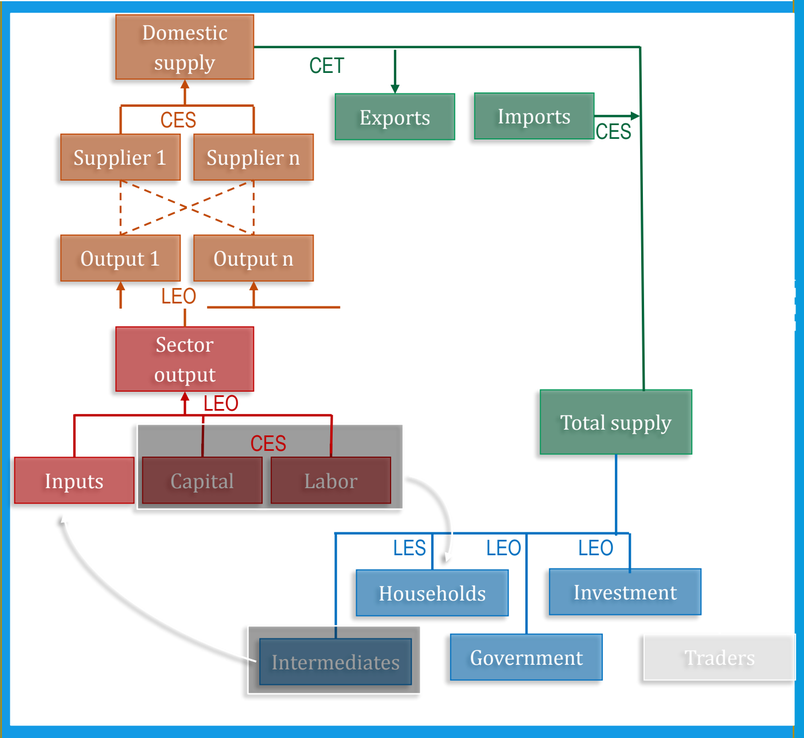
Hogan, Manne, and others 1977, Hourcade et al. 2006 , Böhringer and Rutherford 2008,…

Energy Model – SATIM (SA TIMES Model)





Economic Model eSAGE (IFPRI std.model+dyn.+e)



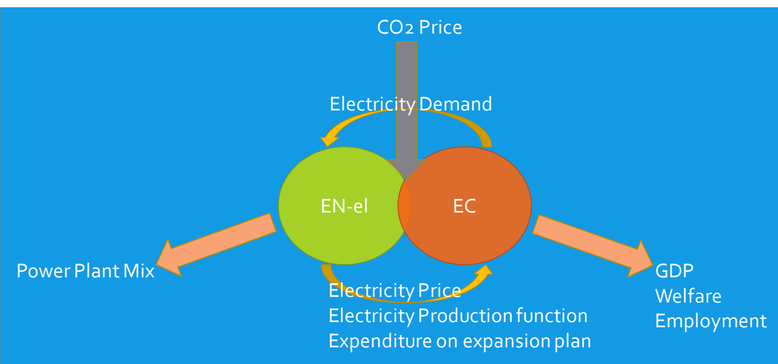
Research Goals

To develop an energy-economy framework that is technically relatively sound, provides policy insights in terms of socio-economic indicators (such as GDP and welfare) when considering energy and climate mitigation policies.

To evaluate if the linked modelling framework has significant advantages over the simpler approaches, including using each model separately by using two policy case studies:

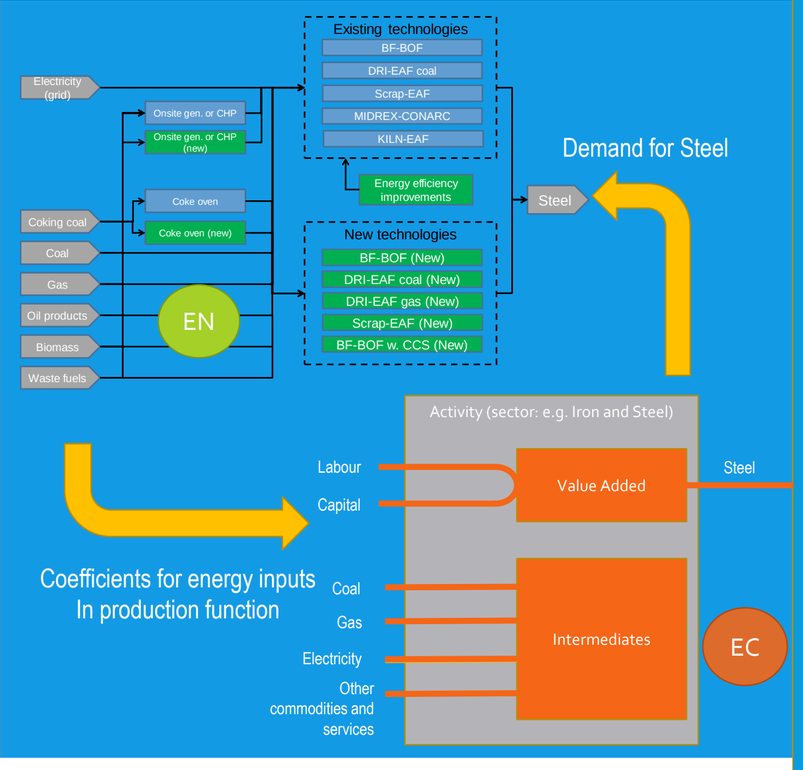
- One relating to how the economy would benefit from improved energy efficiency (EE)
- One relating to the broader issue of decarbonizing the South African Energy system (CO_2: 10GT cumul. between 2015-2050)

Previous Work

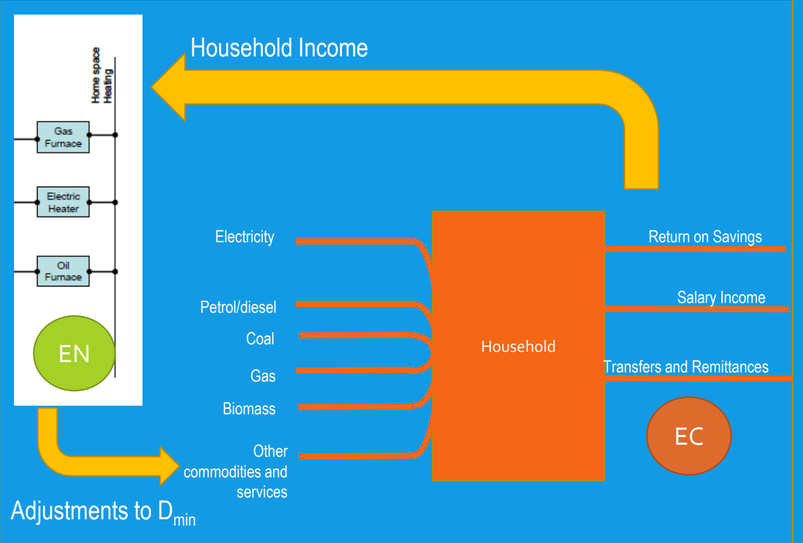


Altieri et al. 2016, Arndt et al. 2014

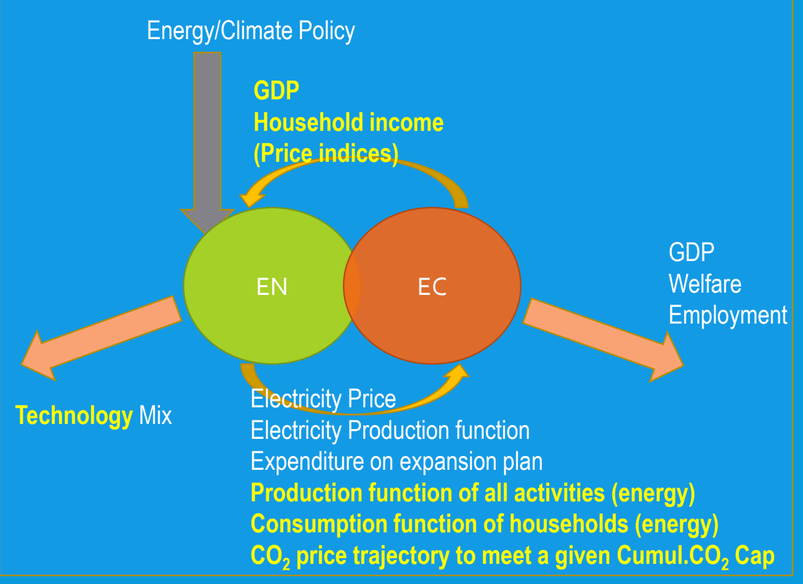
New Links: Economic Sectors



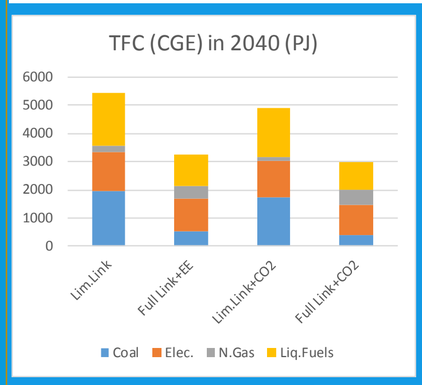
New Links: Households



New Links: Iterations

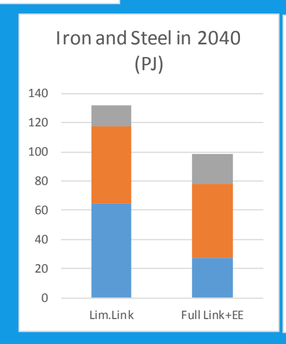


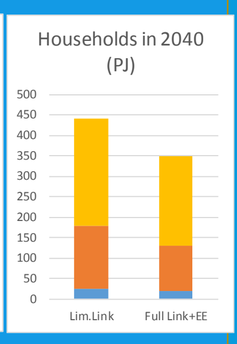
Results – Energy

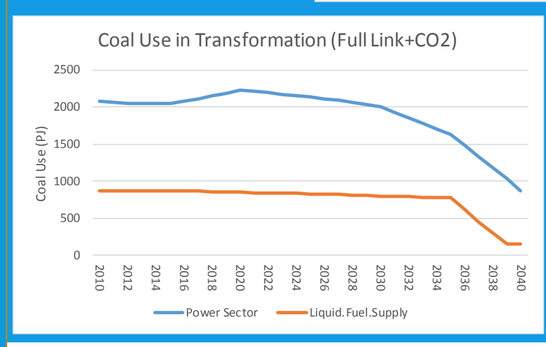


Total Final Energy consumption drops by 42% by 2040 when the full link is enabled, compared to the simple case (no link and no EE in the CGE). The TFC includes energy consumed by activities (incl. freight and public transport) and households (incl. private transportation).

Drawing from the detailed modelling of the different steel making processes, the CGE sees a drop of 23% in energy required to make steel + a slight switch from coal to electricity and Natural Gas.

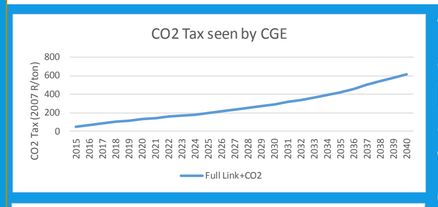


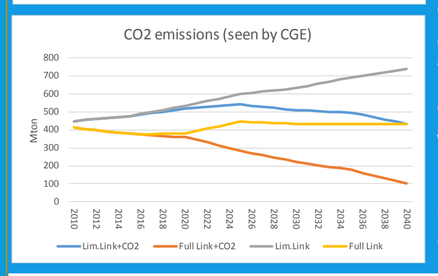




The full link allows the CGE to not only decarbonize the production of electricity but also that of liquid fuels by 2040 in the CO_2 constrained case.

Results – CO_2





To achieve the 10 GT cumulative CO_2 target (lower PPD), the CO_2 price reaches ~600 R/ton by 2040.

Without the full link, the CGE doesn't manage to reduce CO_2 emissions much.

The full link allows the emissions to stabilize even without a CO_2 tax when EE is implemented. The CO_2 drops substantially when the constraint/tax is imposed.

Results – Economy

All sectors show improvement in growth (except for Agriculture where no EE is modelled), when EE is implemented. Without the link the economy suffers when the CO_2 price is imposed. But it recovers when the full link is enabled, as the economy is more efficient and less reliant on coal. This economic boost is reflected on welfare.

Conclusions and Further Work

We describe how we further couple a least-cost optimization energy model (SATIM) to a dynamic general equilibrium model (eSAGE) to benefit from the strengths offered by each approach.

The coupling improves the confidence of the technical plausibility of the general equilibrium model, when implementing EE and ambitious CO_2 reductions targets. The results of the CGE can be use to draw some more robust policy insights compared to the simpler approach.

We demonstrate this using two examples: a set of EE measures, and an ambitious CO_2 reduction target.

Further work includes:

- The use of more recent SAM for the characterization of the economy (2007 SAM used here)
- Further effort in base year calibration to further enhance characterization of energy use in the economy
- EE not properly costed in CGE yet
- Further case studies in more detail

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- Altieri, Katye E, Hilton Trollip, Tara Caetano, Alison Hughes, Bruno Merven, and Harald Winkler. 2016. "Achieving Development and Mitigation Objectives through a Decarbonization Development Pathway in South Africa." Climate Policy. Taylor \& Francis, 1–14.
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  - Hourcade, Jean-Charles, Mark Jaccard, Chris Bataille, and Frédéric Ghersi. 2006. "Hybrid Modeling: New Answers to Old Challenges Introduction to the Special Issue of' The Energy Journal.'" The Energy Journal. JSTOR, 1–11.